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APR 23 1997

January 1997

Science 30

Grade 12 Diploma Examination

Alberta
EDUCATION

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January 1997

Science 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A science data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. science
B. biology
C. physics
D. chemistry

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

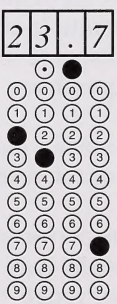
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



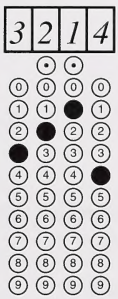
Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

Record 3214 on the answer sheet →



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

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A Caribbean island has actively promoted tourism in order to expand its economic base. The island has three unique geographic regions, providing a biodiversity that attracts tourists with varying interests.

1. Tourists are advised to obtain cholera vaccinations before arriving on the island. The vaccine protects them against cholera for a number of years by causing the production of

A. platelets
B. antigens
C. killer T cells
D. memory T cells

Use the following information to answer the next question.

A Reaction that Occurs in the Sun

$$ {}^{2}_{1}\mathrm{H} + {}^{2}_{\mathbf{A}}\mathrm{H} \rightarrow {}^{\mathbf{B}}_{2}\mathrm{He} + {}^{\mathbf{C}}_{\mathbf{D}}\mathrm{n} $$

Numerical Response

1. The use of sunscreens is recommended during daylight hours. The energy that causes skin to tan or burn is derived from nuclear reactions that occur in the Sun.

Record the numbers represented by the letters to correctly balance the above equation.

A is _____ (Record in column 1 on the answer sheet.)
B is _____ (Record in column 2 on the answer sheet.)
C is _____ (Record in column 3 on the answer sheet.)
D is _____ (Record in column 4 on the answer sheet.)

2. Despite their precautions, some tourists found that they were still susceptible to sunburn. Exposure to ultraviolet radiation has increased **mainly** due to the production of

A. pesticides

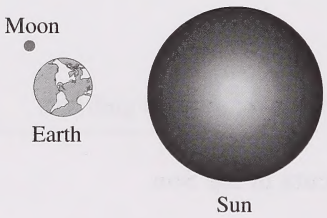
B. carbon monoxide

C. hydrogen sulphide

D. chlorofluorocarbons

3. The island relies on tidal energy. Twice a month, a spring tide (very high and very low water levels) occurs. The diagram that correctly shows the relative positions (not to scale) of the Sun, Moon, and Earth during one such tide is

A.



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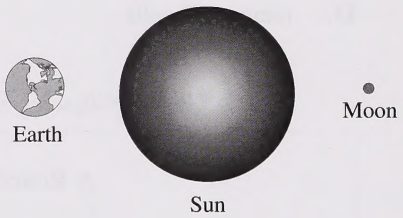

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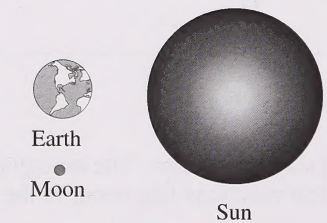

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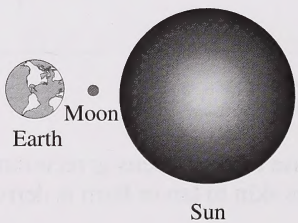


Use the following information to answer the next question.

Stars Matched with Their Colours

1	Rigel	blue-white
2	Acturus	orange
3	Betelgeuse	red
4	Fomalhaut	green

Numerical Response

2. One evening, some tourists went to an observatory. A guide explained that the hotter an object is, the shorter the wavelengths that it emits. The tourists realized that this explained the varied colours of stars. Therefore, the stars in the above chart, listed from **coolest to hottest**, are

_____ , _____ , _____ , _____
(coolest) (hottest)

(Record all **four** digits on the answer sheet.)

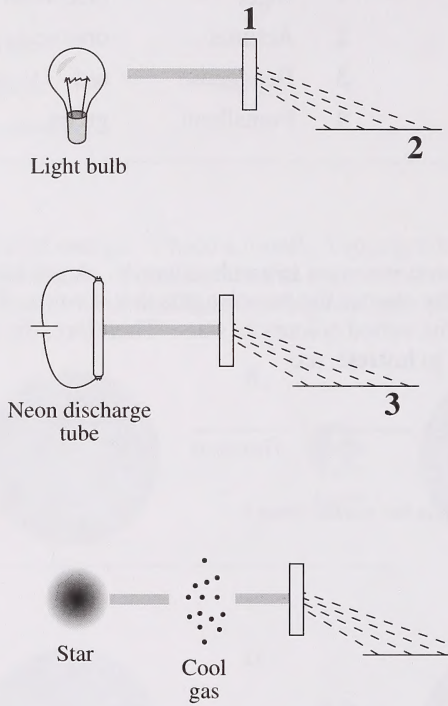
Numerical Response

3. The guide told them that in 1994 an observer in New Zealand witnessed the appearance of a supernova in the galaxy of Set Alpha Omega. If this galaxy is 1.27×10^{19} m from Earth, the supernova occurred _____ years earlier than 1994. (The number of metres in a light year is given in your data book.)

(Record your answer to **four** digits on the answer sheet.)

Use the following information to answer the next question.

Spectra Produced by a Variety of Sources



Numerical Response

4. The island observatory was set up to demonstrate spectra produced by a variety of sources. Match the following list with the appropriate numbers from the diagram.

Diffraction grating _____ (Record in column 1 on the answer sheet.)

Emission (bright-line) spectrum _____ (Record in column 2 on the answer sheet.)

Absorption (dark-line) spectrum _____ (Record in column 3 on the answer sheet.)

Continuous spectrum _____ (Record in column 4 on the answer sheet.)

Use the following information to answer the next question.

Reaction of Bleach with Water

$$HClO_{(aq)} + H_2O_{(l)} \rightleftharpoons OCl^-_{(aq)} + H_3O^+_{(aq)}$$

4. Fishing is a common practice on the beaches of the island. Although environmentalists advise against it, some fishermen pour bleach into the water to drive lobsters into traps. The water acts as a Brønsted-Lowry

A. acid
B. base
C. buffer
D. indicator

---

5. Abnormalities in shellfish are common. In one type of abnormality, the cells of the shellfish contain an extra chromosome. This would be a result of

A. sex-linkage
B. point mutation
C. nondisjunction
D. recombinant DNA

6. Industrial pollutants can accumulate in marine organisms. Which of the following organisms would have the **highest** concentration of pollutants?

A. Algae
B. Sharks
C. Shrimp
D. Microscopic animals

7. Small changes in pH can be destructive to the coral environment surrounding the island, yet acid rain has a minimal effect because the coral reef has a natural buffering capacity. The compound that is responsible for maintaining a relatively constant pH is

A. $H_2O_{(l)}$
B. $NaCl_{(aq)}$
C. $CaCO_{3(s)}$
D. $MgBr_{2(aq)}$

8. If the pH of the coral waters is 6.80, the hydronium ion concentration $[H_3O^+_{(aq)}]$ is

A. 1.6×10^{-7} mol/L
B. 2.8×10^{-1} mol/L
C. 8.3×10^{-1} mol/L
D. 6.3×10^{6} mol/L

9. Some sources of acid rain may change the pH of rainwater from 6.1 to 4.1. This represents a hydronium ion concentration $[H_3O^+_{(aq)}]$ increase of

A. 2 times
B. 10 times
C. 20 times
D. 100 times

Use the following information to answer the next question.

Sources of Pollution

1 Detergents
2 Car exhaust
3 Tanker ships
4 Pulp and paper industry

Numerical Response

5. Pollution on the island and its surrounding water originates from a variety of sources. Match the pollutant with the source. **Use each number only once**.

A source of phosphates is _____ (Record in column 1 on the answer sheet.)
A source of petrochemicals is _____ (Record in column 2 on the answer sheet.)
A source of nitrogen oxides is _____ (Record in column 3 on the answer sheet.)
A source of dioxins and furans is _____ (Record in column 4 on the answer sheet.)

Use the following information to answer the next question.

Characteristics of Some Insecticides

I Persist in the environment
II Degrade quickly
III Biomagnify in the food pyramid
IV Non-volatile (do not vaporize into the air)

10. Two characteristics of DDT are

A. I and II
B. I and III
C. II and III
D. II and IV

Use the following information to answer the next question.

Components of a Reflex Arc

1. Muscles
2. Motor neuron
3. Sensory neuron
4. Interneuron (Association neuron)

Numerical Response

6. Spearfishing is popular in the shallow waters despite the presence of sharp coral. A fisherman contacting the sharp coral immediately "jumps back." The simplified path that the nerve impulse follows during this reflex response is

_____, _____, _____, _____.

(Record all **four** digits on the answer sheet.)

---

11. Nerve impulses are controlled by substances such as acetylcholine. Acetylcholine is a

A. neurotransmitter that blocks the transmission of an impulse
B. neuroinhibitor that blocks the transmission of an impulse
C. neurotransmitter that stimulates the adjacent neuron
D. neuroinhibitor that stimulates the adjacent neuron

12. When a fisherman is cut by coral, which component of blood is responsible for clotting the blood at the site of the cut?

A. White blood cells
B. Red blood cells
C. Hemoglobin
D. Platelets

13. Spearfishers looking down into the water aim below their intended target. They do this to correct for the fact that light coming from the target is

A. refracted

B. reflected

C. polarized

D. magnified

14. A boat carries an expedition of divers to a site near the island. A radio is used to report the boat's position to island authorities. These radio waves have a frequency of 1240 kHz. The wavelength of the radio waves is

A. 2.42×10^{-1} m

B. 4.13×10^{-3} m

C. 2.42×10^{2} m

D. 3.72×10^{14} m

Numerical Response

7. The radio has a resistance of 7.38 Ω and is powered by a 24.0 V battery. The current drawn by the radio is _____ A.

(Record your answer to **three** digits on the answer sheet.)

15. The boat contains an anchor that is raised by an electric winch. The electric winch draws 2.40 A supplied by a 48.0 V source. If it takes 3 min 35.0 s to raise the anchor, the amount of energy required is

A. 1.08×10^{1} J

B. 1.15×10^{2} J

C. 2.48×10^{4} J

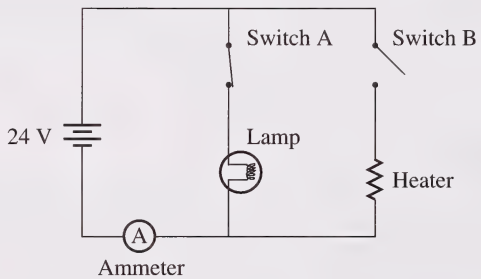
D. 9.90×10^{6} J

16. Two backup motors with resistances of 30 Ω and 15 Ω can be connected in parallel to operate the winch in the event of a failure of the winch motor. When connected in parallel, the total resistance of these motors is

A. 0.02 Ω
B. 0.10 Ω
C. 10 Ω
D. 45 Ω

Use the following information to answer the next question.

Electricity to the wheelhouse of the boat is provided by a 24.0 V generator driven by a belt from the boat's engine. The wheelhouse circuit contains a 60.0 W lamp and an electrical outlet into which a 600 W heater can be plugged. The wiring of the wheelhouse is illustrated below.

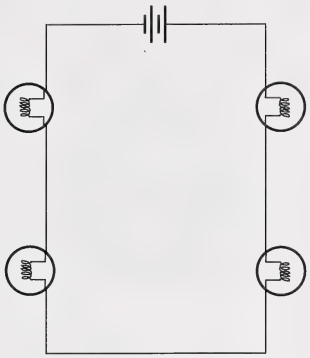


17. When switch A is closed and switch B is open, the reading on the ammeter is

A. 0.400 A
B. 2.50 A
C. 25.0 A
D. 27.5 A

18. The deck lights are wired so that if any light burns out, the other lights still operate. A diagram that represents this circuit is

A.



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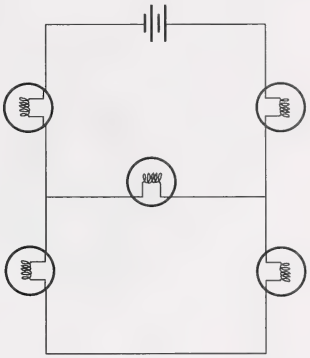
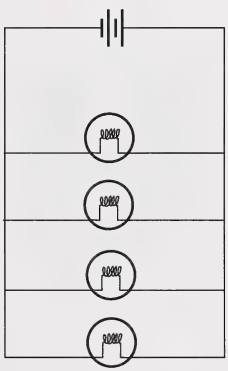


C.



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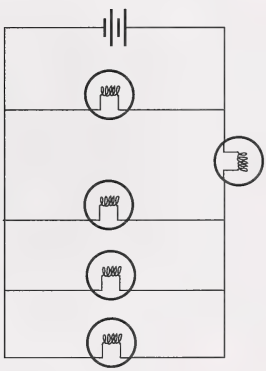
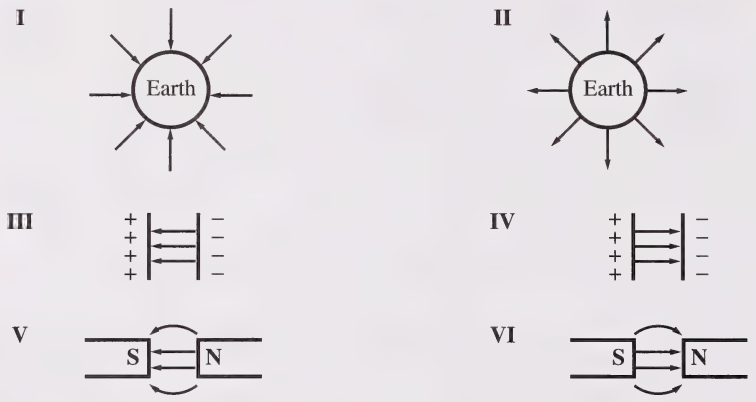


Use the following information to answer the next question.

Fields

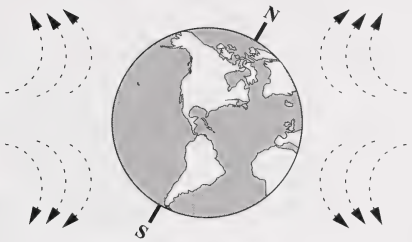


19. The diagrams that represent gravitational, electric, and magnetic fields **respectively** are

A. I, IV, and V
B. I, II, and III
C. IV, I, and V
D. IV, V, and VI

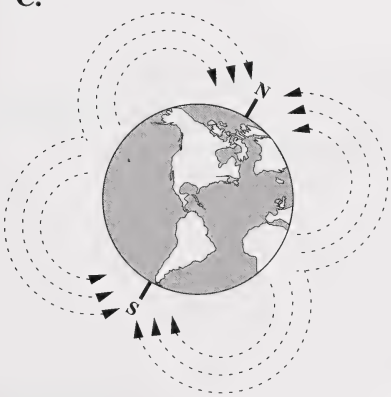
20. The captain of the boat uses a compass to chart a course to the diving site. The diagram that represents the magnetic field of Earth is

A.



B.

C.



D.

Numerical Response

8. As a safety precaution, the captain of the boat constantly monitors wave speed by observing buoys in the diving area. If the waves have a wavelength of 0.655 m/wave and a frequency of 2.00 waves/s, the velocity of the waves is _____ m/s.

(Record your answer to **three** digits on the answer sheet.)

21. The engines that power the boat are designed to operate with a variety of fuels, depending upon their availability. The hydrocarbon that releases the greatest amount of energy on combustion, per mole burned, is

A. methane
B. propane
C. butane
D. octane

22. The process of respiration provides energy for the divers' muscle cells. Respiration is similar to the combustion of fossil fuels in that both produce

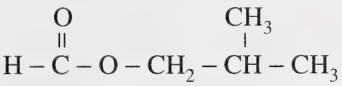
A. water and oxygen
B. glucose and oxygen
C. carbon dioxide and water
D. carbon dioxide and oxygen

23. A 70%-efficient gas furnace heats the dining lounge of the diving boat. This means that 70% of the

A. fuel is natural gas and 30% is oxygen from the air
B. usable heat comes directly from the furnace
C. energy in the fuel is changed to usable heat
D. energy from the fuel is wasted

Use the following information to answer the next question.

Structural Formula for Raspberry Flavouring



24. A popular carbonated beverage served in the dining lounge has a raspberry flavour. Two compounds are reacted to prepare this flavouring. One of the reactants is methanoic acid. The other is

A. methanol

B. 2-ethyl-1-ethanol

C. 2-methyl-1-propanol

D. 2,2-dimethyl-1-ethanol

Use the following information to answer the next question.

Acids Available on Boat

1 $HCl_{(aq)}$

2 $H_2SO_{3(aq)}$

3 $H_3PO_{4(aq)}$

4 $HNO_{2(aq)}$

Numerical Response

9. Divers often retrieve objects that are later subjected to laboratory analysis. The diving expedition returned with some coins that were cleaned using one of four available acids. The acids, listed in order of decreasing strength (strongest to weakest), are _____ (strongest), _____, _____, _____ (weakest).

(Record all **four** digits on the answer sheet.)

25. To determine the concentration of some hydrochloric acid, a diver titrated it with 0.200 mol/L $NaOH_{(aq)}$. A 10.0 mL sample of the acid solution required 14.5 mL of the $NaOH_{(aq)}$ solution to reach the end-point. The concentration of the acid solution was

A. 0.0200 mol/L

B. 0.290 mol/L

C. 1.45 mol/L

D. 2.90 mol/L

Use the following information to answer the next question.

Spectrum of the Sample

Expected Spectral Lines for Known Elements

Element	Principal Spectrum Lines
W	420, 430, 510, 780 nm
X	420, 490, 580, 730 nm
Y	440, 460, 620, 750 nm
Z	440, 530, 640, 770 nm

26. A small sample from a coin was subjected to spectral analysis in order to determine the elements present. The resulting spectrum was compared to the spectra of known elements. Based on the data, the elements present in the coin include

A. W and Z only

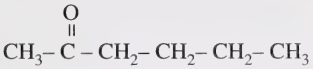
B. X and Y only

C. W, X, and Y only

D. W, X, and Z only

Use the following information to answer the next question.

Formula of the Compound in a Bottle



27. A bottle containing liquid was also retrieved by the diving expedition. The liquid in the bottle was analyzed and found to contain a compound. The name of this compound is

A. 2-hexanone

B. 2-oxyhexane

C. 1-methyl-1-pentanal

D. 2-methyl-2-pentanone

Use the following information to answer the next question.

Results of Testing the Liquid in a Bottle

Indicator	Colour of Solution
Methyl red	yellow
Phenolphthalein	colourless
Bromothymol blue	blue

28. The liquid in another bottle was tested with a series of indicators. The results are summarized in the table. The pH of the solution is within the range of

A. 6.0 to 8.2

B. 6.0 to 7.6

C. 7.6 to 8.2

D. 4.4 to 6.0

Coal, oil, natural gas, and nuclear energy currently provide about 80% of the world's energy needs. Some economists estimate that environmental and health damage arising from the use of these fuels, the so-called hidden costs, outweigh the costs of switching to renewable energy sources.

Use the following information to answer the next question.

Cost/Benefit Factors of Some Energy Sources

1 Non-renewable
2 Few suitable sites
3 Requires large land area
4 Use of CO_2 and production of CO_2 are balanced

Numerical Response

10. In considering possible energy sources, cost/benefit analyses are made. Match the cost/benefit factor to the appropriate energy source.
Use each number only once.

Tidal _____ (Record in column 1 on the answer sheet.)
Solar _____ (Record in column 2 on the answer sheet.)
Biomass _____ (Record in column 3 on the answer sheet.)
Coal _____ (Record in column 4 on the answer sheet.)

29. Which of the following energy sources contributes the **most** to the greenhouse effect?

A. Tidal energy
B. Nuclear energy
C. Fossil fuel energy
D. Hydroelectric energy

30. The burning of fossil fuels contributes to the formation of acid rain. The chemical reaction that represents the production of acid rain from a combustion product is

A. $2\ NO_{(g)} + O_{2(g)} \rightarrow 2\ NO_{2(g)}$

B. $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$

C. $HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

D. $NH_{3(g)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$

31. Sulphur dioxide emissions from a coal-fired plant could be reduced by

A. installing a scrubber

B. installing a catalytic converter

C. burning a lower grade of coal

D. carrying out combustion at a lower temperature

Use the following information to answer the next question.

Energy Conversions

Solar $\rightarrow$ Chemical $\rightarrow$ Thermal $\rightarrow$ Mechanical $\rightarrow$ Electrical

I **II** **III** **IV**

32. The energy conversion common to both coal-fired and tidal electricity generation is conversion

A. I

B. II

C. III

D. IV

33. Which of the following energy sources **cannot** be traced back to the Sun?

A. Wind
B. Fossil fuels
C. Geothermal power
D. Hydroelectric power

34. Tides are used to produce electrical energy. Which step in the process involves the transformation of potential energy to mechanical energy?

A. Water is released, turbines rotate
B. Sluices (gates) close, water is trapped
C. Armature rotates through a magnetic field
D. Low-voltage energy goes into a transformer, high-voltage energy comes out

Numerical Response

11. One reaction that occurs within a CANDU reactor is

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3\,{}^{1}_{0}\mathrm{n}.$$

The amount of energy released per mole of $^{235}_{92}\mathrm{U}$ consumed is
_____ __•__ _____ _____ $\times 10^{X}$ J/mol.
(The masses of the reactants and products can be found in the data booklet.)

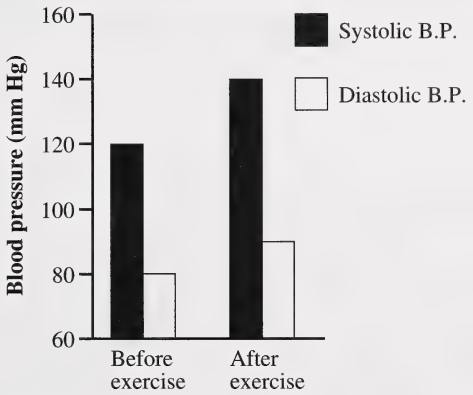
(Record your answer to **three** digits on the answer sheet)

The ability to design and interpret scientific studies is an important component of science literacy.

Use the following information to answer the next three questions.

A group of students designed an experiment to investigate the relationship between exercise and blood pressure. They measured the blood pressure of ten healthy students at rest and again immediately after running for five minutes.

Blood Pressure Before and After Exercise



35. The data from the experiment were collected, averaged, and plotted as shown in the graph. A reasonable inference that can be drawn from the graph is that, during exercise,

A. systolic pressure increases and diastolic pressure increases

B. systolic pressure increases and diastolic pressure decreases

C. systolic pressure decreases and diastolic pressure increases

D. systolic pressure decreases and diastolic pressure decreases

36. The responding variable in the experiment was the

A. exercise
B. blood pressure
C. number of students
D. health of the students

37. During the lab, the fire alarm rang. This startled some students, who experienced

A. an increase in heart rate and a decrease in blood pressure
B. an increase in heart rate and an increase in blood pressure
C. a decrease in heart rate and a decrease in blood pressure
D. a decrease in heart rate and an increase in blood pressure

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Use the following information to answer the next three questions.

The students read about a study in The Netherlands. The researchers said that acid rain was a threat to songbirds in Dutch forests. A survey of three species of songbird in 60 forests revealed that 30% to 50% of the birds were laying eggs with defective shells. The problem was identified as a calcium deficiency. The songbirds get most of their calcium from eating the shells of land snails, which get calcium from plants, which absorb it from the soil. Over the past 20 years, the snail population has plummeted to nearly zero. Researchers blame acid rain, which leaches calcium out of the soil, washing it into groundwater, rivers, and finally out to sea.

38. Forests in The Netherlands may be deficient in calcium and susceptible to acid rain because the bedrock is composed of

A. granite, which acts as a buffer
B. limestone, which acts as a buffer
C. granite, which does not act as a buffer
D. limestone, which does not act as a buffer

39. In order to confirm that the songbirds were suffering from a calcium deficiency, the researchers fed birds in one part of a forest a diet supplement of snail shells and compared their eggs with a control group. The responding variable in the experiment is the

A. pH of the soil

B. number of snail shells

C. thickness of the egg shells

D. amount of calcium in the snail shells

40. In the Dutch forests, the soil's calcium content is 0.3 g per kg of dry matter (5 to 10 g is normal). What should be added to the forest soil to boost calcium levels?

A. Lime

B. Ammonia

C. Phosphates

D. Wood chips

Use the following information to answer the next question.

Are Electromagnetic Fields Tied to Cancer?

A major study investigated the relationship between electromagnetic fields generated by electrical current and the incidence of leukemia (cancer of the blood) among utility workers. The study was the result of mounting concern that a cancer risk may be associated with electromagnetic fields. The researchers found that despite the 223 000 workers studied in Quebec, Ontario, and France, the study failed to provide any definitive evidence of a link.

41. The information suggests that

A. the study was not well designed

B. there is no definite link between leukemia and electromagnetic fields generated by electrical currents

C. the risk of getting leukemia is greater for the general population than for the 223 000 utility workers

D. results obtained from utility workers cannot be applied to the general public, whose exposure is not as high

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42. Exposure to electromagnetic radiation may cause mutations in DNA. Radiation **most likely** to cause damage to DNA would have

A. short wavelengths because they have high energy

B. short wavelengths because they have low energy

C. long wavelengths because they have high energy

D. long wavelengths because they have low energy

Use the following information to answer the next question.

Types of Electromagnetic Radiation

1 Radio
2 X-ray
3 Visible
4 Gamma

Numerical Response

12. The types of electromagnetic radiation listed in order of increasing frequency are _____ , _____ , _____ , _____ .

(Record all **four** digits on the answer sheet.)

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43. Radiation or chemicals that cause damage to DNA are called mutagens. A mutation is

A. a breakage of the chromosomes
B. a nondisjunction of the chromosomes
C. an alteration of the base sequence in DNA
D. an alteration of the amino acid sequence in DNA

44. One genetic mutation that has been passed along for generations causes cystic fibrosis. The gene that causes the disease is recessive to the normal gene. The chance that a child from two heterozygous parents (carriers) will inherit the disease is

A. 25%
B. 50%
C. 75%
D. 100%

The written-response questions begin on the next page.

For the written-response questions, use complete sentences.
You may use tables, graphs, and diagrams where appropriate.

Written Response – 15% (12 marks)

1. There are many ways to generate the electrical energy needed to satisfy the power needs of a country such as Canada. In every case, however, there are costs involved in the production of that electricity. For example, for every kilowatt-hour (kW•h) of electricity produced by using a new generation of gearless wind turbines, there is a cost of 7.5¢ / kW•h. Coal-burning power plants may generate electricity at a cost of 6¢ / kW•h. Photovoltaic cells can convert light energy into electrical energy at a cost of 40¢ / kW•h.

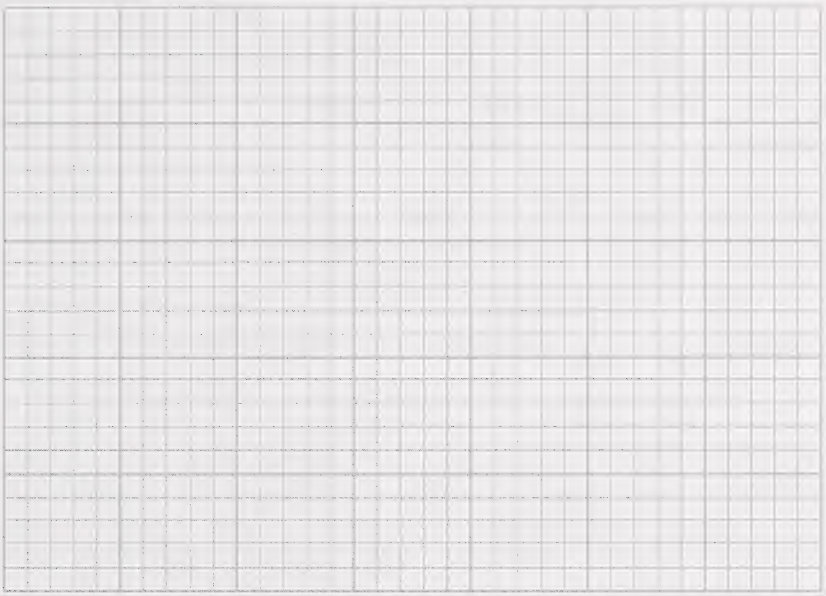
a. Complete a data table to present the data given in the paragraph above.

Title: _____

Continued

b. Prepare a graph that displays the data about the costs of producing electrical energy using these three different technologies.

Title: _____



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c. Some scientists suggest that the pollution costs of generating electrical energy by using coal as a fuel is at least an additional 3¢ / kW•h. Compare the advantages and disadvantages of the use of coal-burning power plants with the use of wind generators. Include a detailed risk/benefit analysis. Describe the circumstances or conditions that would make the use of the wind generators feasible.

Continued

Continued

Written Response – 15% (12 marks)

2. Select a human disease or disorder. It may be viral, bacterial, or genetic, or it may be a disease that affects the circulatory or nervous system. Explain its mode of operation and how it affects the body. Describe the scientific and technological methods that are being used to treat and prevent the disease or disorder.

Continued

You have now completed the examination.
If you have time, you may wish to check your answers.

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